The Collider Rings

The complete RHIC facility will be a complex set of accelerators interconnected by beam transfer lines. A significant portion of the collider itself already exists: A complete injector system will be in operation independently of the collider; the injection tunnels from the AGS, the main 3.834 km long tunnel, support buildings, four completed experimental areas (two additional undeveloped experimental areas also exist), and a central control building are available; a cryogenic refrigerator system is complete which has the capacity to meet RHIC requirements. The RHIC tunnel is located towards the northwest corner of the Brookhaven site. The site plan in Fig. 1 shows all major components of the RHIC complex.

The part of the RHIC project covered by this Design Manual includes the construction of a heavy ion collider facility consisting of two intersecting superconducting storage rings in the existing tunnel, the beam transfer line from the AGS to the collider rings, and the ancillary accelerator systems required for the collider operation.

Bending and focusing of the ion beams is achieved by the ring magnets. In view of the fixed tunnel circumference, a cost optimization indicates that filling the circumference with relatively low-field superconducting magnets is most economical. At a magnetic field of about 3.458 T, the energy is 100 GeV/u for gold and 250 GeV for protons. The required field is generated with single-layer cosine-theta magnets which, for maximum operational flexibility, are contained in vacuum vessels separate for each ring, except those near the collision points.

The collider consists of two rings of superconducting magnets. The main components of the magnet system are 288 arc-size dipoles and 108 insertion dipoles, and 276 arc and 216 insertion quadrupoles. In addition to dipoles and quadrupoles, there will be an inventory of smaller magnets consisting of 72 trim quadrupoles, 288 sextupoles and 492 corrector magnets at each quadrupole. The arc dipoles have a physical length of 9.728 m (9.45 m effective), are bent with a 4.85 cm sagitta and have a coil aperture of 8 cm in order to accommodate the requirements due to intrabeam scattering. The cold bore beam tube aperture was chosen to be 69 mm in diameter. The beams in the arcs will be 90 cm apart. The magnets are cooled to a temperature of <4.6 K by circulating supercritical helium which is supplied by the existing 24.8 kW refrigerator. A suitable helium distribution system will be provided. The various ring magnets will be excited by an appropriate power supply system and protected by a quench protection system.

The beam tube in the superconducting magnets is at the temperature of liquid helium. An extremely good vacuum with a pressure $<10^{-11}$ mbar may be obtained, in the absence of leaks into the cold bore. In order to avoid beam loss and radiation background, a vacuum of about 7×10^{-10} mbar is required in the warm beam tube sections of the insertion regions.

The cryostats for the superconducting magnets require a separate insulating vacuum of less than 10^{-5} mbar in order to avoid a heat load due to convection.

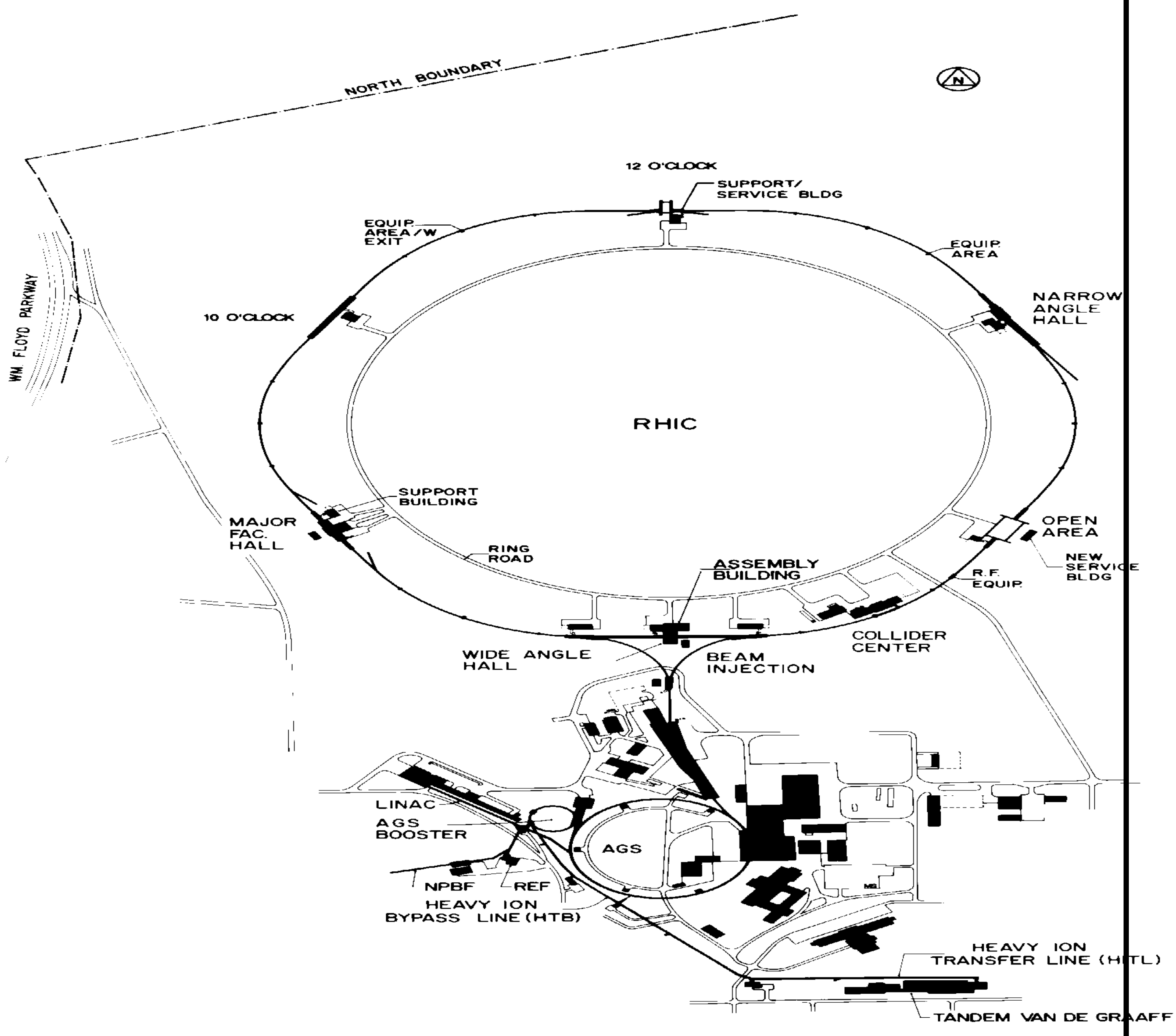

Fig. 1. Layout of RHIC Project - Collider & Injector.